Final Public Report for ESA-091, Arrow United

Introduction:
The plant manufactures aluminum louvers and dampers for commercial HVAC applications. The plant recently installed an integrated paint line containing a parts washer, drying oven and cure oven; these are the only process heating applications in the plant.

Objective of ESA:
The assessment sought to identify fuel saving opportunities for the parts washer, drying oven and cure oven applications.

Focus of Assessment:
The newly-installed integrated paint line was purchased from a supplier known for high quality products and engineering. Thus, there are no energy savings opportunities due to oversized equipment, malfunctioning equipment, un-calibrated equipment, or equipment designed during a period of inexpensive energy costs. The savings opportunities that were identified are from process integration and extending energy conservation approaches beyond those already incorporated into the equipment.

Approach for ESA:
Introductory meeting
Tour of process heating applications
Presentation of process heating fundamentals to staff
Measurements and observations
Development of baseline PHAST model
Identification of savings opportunities
Modeling savings opportunities in PHAST to quantify savings
Report development
Close-out meeting

General Observations of Potential Opportunities:

- The paint line was just installed and includes a washer, dry-off oven and cure oven. These are the only process heating applications in the plant. These applications use propane as fuel. According to management, current propane costs are between $1.20 and $1.60 per gallon; looking forward, this assessment used $1.60 per gallon as the future cost of propane and assumed 92,000 Btu/gallon as the energy content of propane (which varies from supplier to supplier). Using these numbers, the cost of propane is about $17.40 /mmBtu.
- Based on burner ratings, the manufacturer estimated peak propane use at 35 gallons per hour. The baseline PHAST analysis estimated hourly use at about 28 gallons of propane per hour or 2.6 mmBtu/hr during heavy use. According to management, the paint line will run about 40 hours per week for 50 weeks per year, for a total of about 2,000 hours per year. Using these numbers, annual propane use would be about 56,600 gallons/year or 5,200 mmBtu/year. Annual propane cost would be about $89,600 /year.
- The savings opportunity to further reduce the temperature of the cure oven from 420 F to 400 F would be a near term opportunity, since it involves no capital cost. All other savings opportunities identified are medium term opportunities since they involve the purchase of new equipment, and require further engineering and return-on-investment analysis.
- The assessment identified several possible savings opportunities. Management suggested that each saving opportunity be quantified individually, so that the opportunities could be further investigated and the best opportunities selected for implementation. Thus, the total achievable savings are less than the sum of the individual savings since many of the individual opportunities are alternatives that could not be simultaneously implemented. However, the savings from simply implementing Savings Opportunity 1 and 2 would be about $22,100 per year, which represents about 24% of annual propane costs.
- Savings Opportunities are summarized below.

  <u>Reduce Cure Temp from 420 to 400 F</u>
  The cure oven was designed to operate at 450 F based on a maximum load of the heaviest parts. Subsequent testing with a data recorder has enabled the oven temperature to be reduced to 420 F. Management believes that it may be possible to further reduce the temperature to 400 F. Using PHAST the savings are estimated to be about:

  158,000 Btu/hr x 2,000 hr/yr = 316 mmBtu/yr
  316 mmBtu/yr x $17.40 /mmBtu = $5,500 /yr

  The implementation cost is estimated to be negligible for an immediate simple payback.

Heat Wash Water with Cure Exhaust

About 1,800 cfm of 400 F air is exhausted from the cure oven. About 20 gpm of wash water at 120 F could be circulated through recuperator in the cure oven exhaust to preheat the wash water. The mass capacitances of the two flows are:

Mcpa = 1,800 cfm x 0.018 Btu/ft3-F = 32.4 Btu/min-F
Mcpw = 20 gpm x 8.32 lb/gal x 1 Btu/lb-F = 166 Btu/min-F
Mcp,min = Mcpa = 32.4 Btu/min-F

Assuming the water heater is 80% efficient and the recuperator is 70% effective, the savings would be about:

70% x 32.4 Btu/min-F x (400 – 120) F x 60 min/hr / 80% = 476,000 Btu/hr
476,000 Btu/hr x 2,000 hr/yr = 953 mmBtu/yr
953 mmBtu/yr x $17.40 /mmBtu = $16,600 /yr

The implementation cost is estimated to be about $5,000 for a 4 month simple payback.

Preheat Cure Combustion Air

A simple concentric-tube heat exchanger could be installed to pre-heat the cure combustion air with cure exhaust. Using PHAST the savings are estimated to be about:

47,000 Btu/hr x 2,000 hr/yr = 94 mmBtu/yr
94 mmBtu/yr x $17.40 /mmBtu = $1,600 /yr

The implementation cost is estimated to be about $1,000 for a 7 month simple payback.

Preheat Dryoff Combustion Air

A simple concentric-tube heat exchanger could be installed to pre-heat the dryoff combustion air with dryoff exhaust. Using PHAST the savings are estimated to be about:

29,000 Btu/hr x 2,000 hr/yr = 58 mmBtu/yr
58 mmBtu/yr x $17.40 /mmBtu = $1,000 /yr

The implementation cost is estimated to be about $1,000 for a 12 month simple payback.

Modulate Cure Combustion Air

To maintain zone temperature in the cure oven, natural gas is modulated while combustion air is kept constant. However, the burner rarely operates above 75% of full fire. This indicates that the quantity of combustion air may be able to be reduced. We estimate that modulating combustion air would enable the average exhaust oxygen content to be reduced from 15% to 13%. Using PHAST the savings are estimated to be about:

68,000 Btu/hr x 2,000 hr/yr = 136 mmBtu/yr
136 mmBtu/yr x $17.40 /mmBtu = $2,400 /yr

The implementation cost is estimated to be about $2,400 for a 12 month simple payback.

Modulate Dryoff Combustion Air

To maintain zone temperature in the dry-off oven, natural gas is modulated while combustion air is kept constant. However, the burner rarely operates above 75% of full fire. This indicates that the quantity of combustion air may be able to be reduced. We estimate that modulating combustion air would enable the average exhaust oxygen content to be reduced from 19% to 17%. Using PHAST the savings are estimated to be about:

27,000 Btu/hr x 2,000 hr/yr = 54 mmBtu/yr
54 mmBtu/yr x $17.40 /mmBtu = $900 /yr

The implementation cost is estimated to be about $2,400 for a 32 month simple payback.

Route Cure Exhaust into Dry-off

About 1,800 cfm of 400 F air is exhausted from the cure oven. The dry-off oven operates at about 250 F. Using PHAST the savings from cascading cure exhaust into the dry-off oven are estimated to be about:

27,000 Btu/hr x 2,000 hr/yr = 54 mmBtu/yr
54 mmBtu/yr x $17.40 /mmBtu = $900 /yr

The implementation cost is estimated to be about $4,000 for a 53 month simple payback.

Management Support and Comments:
Management called the assessment a great learning experience. Learning took place during the presentation of process heating fundamentals, data collection, development of the PHAST model, and identification and quantification of savings opportunities. Management is already comfortable running the PHAST program and intends to use it in the future. Management intends to aggressively investigate these savings opportunities and implement those which are cost and process effective.

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